QWIC-URB and QWIC-PLUME

Fast Response Urban Dispersion Modeling System

Due to the threat of a terrorist releasing a chemical or biological (CB) agent in a city, the Los Alamos National Laboratory has been working on urban fast response plume transport and dispersion modeling under the Chemical and Biological National Security Program (CBNP). Fast response models are essential for vulnerability assessment studies where many cases must be simulated in a limited amount of time or where an answer is needed quickly. The dispersion of a CB agent released in an urban area is difficult to predict, however, due to the presence of buildings. Most dispersion models currently in use for emergency response applications have little or no urban "awareness".

We are developing a fast-response urban dispersion modeling system that will compute the three-dimensional wind patterns and dispersion of airborne contaminants around clusters of buildings. The system is composed of two computer codes: QWIC-URB and QWIC-PLUME.

QWIC-URB, the wind model, is based on the work of Röckle (1990). It uses empirical algorithms to estimate the velocities behind buildings in the cavity and wake and between buildings in the street canyon. A diagnostic wind scheme is then used to adjust the winds to account for mass conservation and obstacle blocking effects. The diagnostic approach was chosen, rather than a potential flow model, because it allows for more realistic rotational flow. Figure 1 shows particle paths from a QWIC-URB computed flow field around two buildings.

QWIC-PLUME is the transport and dispersion model. It is based on a Lagrangian framework, that is, it tracks the movement of particles as they disperse through the air. QWIC-PLUME utilizes

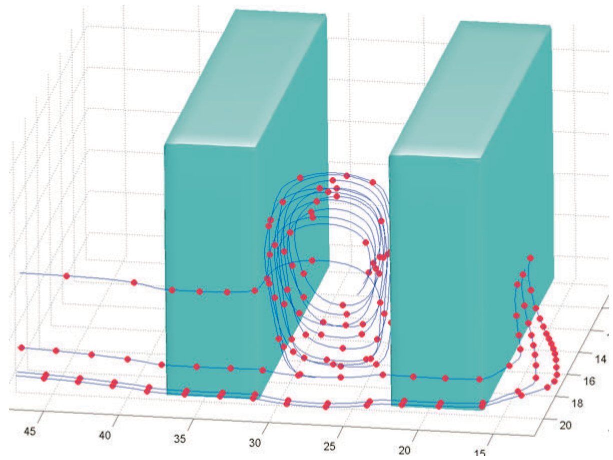

Figure 1. Example of a QWIC-URB computer simulation of the air flow around two buildings. The ambient flow is from left to right. The particle paths reveal the clockwise circulation of the vortex that develops in the street canyon between the two buildings.

the mean flow fields computed by QWIC-URB and produces the turbulent dispersion of the airborne contaminant using the Langevin equations (Rodean, 1996). QWIC-PLUME has been adapted to account for particle reflection on building surfaces and for the additional dispersion due to hori-

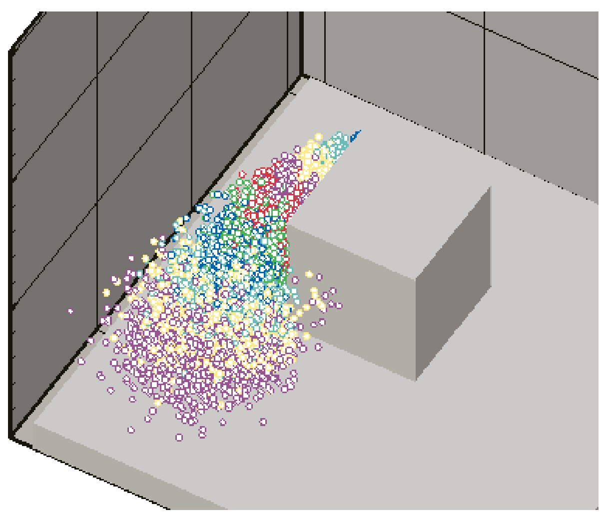

Figure 2. QWIC-PLUME simulation of particles dispersing around an isolated cube. Wind fields were obtained from the QWIC-URB computer model.

zontal inhomogeneities in the turbulence field. Figure 2 shows an example of a computer simulation of particles dispersing around a cube. The simulation required about 10 seconds on a standard modern PC.

The objective of this effort is to make a significant advance in the "best-available" predictions for urban planning and vulnerability assessment applications, while still acheiving very quick turnaround and ease-of-use. There is a significant amount of work still to be done before utilizing the codes in real cities. Model evaluation and testing is critical. Currently we are testing the models against wind-tunnel experimental data (Pardyjak and Brown, 2001 & 2002). Improvements in the empirical algorithms and physical parameterizations need to be made to both codes (e.g., Williams et al., 2002). Development of a prototype graphical user interface is just being started. User's manuals and theory guides are being written (e.g., Williams, 2002).

The QWIC-URB and QWIC-PLUME codes are intended for use in planning, assessment, and emergency response scenarios. Examples include developing scenarios for table top exercises, planning strategies for coping with emergencies at special events, and developing vulnerability analyses and mitigation strategies for specific sites. The two codes will also be used in a sensor siting tool, a

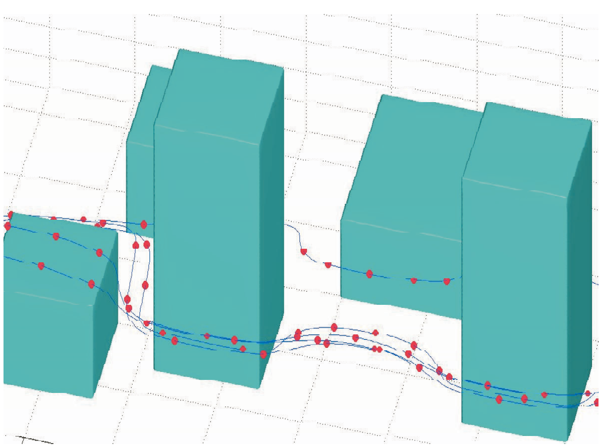

Figure 3. Example of a multi-building wind flow simulation performed with the QWIC-URB computer model.

tool to help determine the optimal placement of CB agent sensors in cities. QWIC-URB and QWIC-PLUME will also be utilized in two important homeland defense programs, the National Biological Defense Initiative and the Biological Aerosol Sentry Information System (BASIS), providing fast response urban dispersion capabilities.

In the longer term, these models will be integrated into the DOE-supported CB-NARAC chem-bio emergency response system. Ultimately, our goal is to develop a fast response modeling system that can be used to give credible agent dispersal patterns in an urban environment. This research effort fills a significant void between fast low fidelity dispersion models and slower high fidelity models.

References:

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